FUTURE ECOSYSTEM RESEARCH

In 1998, the Woods Hole MBL Ecosystems Center received money from the National Science Foundation to create a six year Long Term Ecological Research (LTER) site in Plum Island Sound. This study builds on the LMER project previously described by studying how such things as climate, sea level, and land use continue to effect the Plum Island Sound estuary. The LTER program will focus specifically on the following question: How will trophic structure and primary and secondary productivity in estuaries be affected by changes in organic matter, and nutrient and water fluxes from changing land cover, climate, and sea level? (Woods Hole MBL 1999).

The LTER program will try answering this question through: 1) short and long-term measurements of organic carbon (C) and organic nitrogen (N) entering estuaries from land, marshes and the ocean, 2) short and long-term experiments to determine the effects of various nutrient and organic matter inputs and interactions on the flow of C and N through pelagic and benthic food webs, and 3) modeling the effects of land use changes on food web transformations (Woods Hole MBL 1999). In addition to periodic sampling for these studies, parameters continuously monitored at several locations in the Parker and Ipswich Watersheds include weather, nutrient run-off, river discharge, sea level, and estuarine water quality (dissolved oxygen, pH, florescence, temperature, and salinity). *To see results and ongoing LTER project updates, visit the website at http://www.mbl.edu/PIE/.*

Current LTER research is focused in seven areas: 1) microbial ecology, 2) benthic biogeochemistry, 3) nitrogen tracers, 4) higher trophic levels, 5) intertidal marshes, 6) watersheds, and 7) systems modeling. Each of these areas is briefly described below.

1) **Microbial ecology** researchers are investigating how salt marsh organic matter is linked to estuarine waters by looking at the source and carbon content of bacterial food. The age of carbon, its origins and sinks are being studied to describe carbon cycling and bacterial dynamics (Hobbie per comm 2000).

2) **Benthic biochemistry** researchers are focusing on benthic use and recycling of nutrients/ organic matter and how these vary with changes in water fluxes and organic inputs. Studies are designed to investigate the effects of changing salinity on benthic processes and how annual and seasonal variation of benthic nutrient flux changes with sea level rise (Giblin per comm 2000).

3) **Nitrogen tracer** experiments are focusing on nitrogen concentrations and seasonal chlorophyll levels. As part of this study, the pathway of nitrogen is traced to biotic production (i.e., phytoplankton, zooplankton). Nitrogen discharge, dispersion, and use in primary production are being characterized for the Parker and Rowley Rivers (Peterson per comm 2000).

4) The structure and function of **higher trophic levels** (which include such things as benthic invertebrates, zooplankton, macroalgae, and fish) and their response to variations in organic matter, nutrients, and water fluxes is another research area. As part of these studies, plant sources as well as benthic and pelagic animals are being studied to track changes in the food web.

As part of these higher trophic studies, fish species abundance and the effect of habitat alteration and predation are also being investigated. Both average monthly river discharge and sea level rise are monitored to determine if habitat is a cause of fish population dynamics (Deegan per comm 2000). In addition, the role of striped bass predation on food web dynamics is being studied in the Parker, Rowley, and Essex Rivers by scientists at UMass Boston. Differences across tides, temperature, and estuary configuration all affect these top predators and their impacts on prey species. Data being collected to understand predator/prey interactions include relative predator and prey species abundance, diet, fish condition, weight, age, and growth (Mather per comm 2000).

5) A long term data base describing the structure and function of **intertidal marshes** around Plum Island Sound is being developed. As part of this study, scientists are trying to understand the functional relationships between the salt marsh and estuary. To determine how climate regulates marsh structure and function, plant production, sedimentation, and sediment chemistry are being monitored at control and experimental sites. Another objective of this study is to determine if anomalies in sea level affect the productivity of marsh plants in Plum Island Sound (Morris per comm 2000).

6) **Watershed** studies are focusing on the magnitude and pattern of organic C and N and inorganic N loading from watersheds to the estuary. Nutrient fluxes into the system have accelerated with increased development and agricultural use of the land. This research is focusing on the hydrology and flushing rates, land cover patterns, and origins, sinks, and seasonality of nutrient inputs (Vorosmarty per comm 2000).

7) Several **systems modeling** projects are underway as part of the LTER project. A nutrient transport model is used to predict water and nutrient export and to help understand what causes patterns and differences of nutrient flux in the watersheds. Studies will investigate how to distinguish nutrient loading from terrestrial and aquatic systems by looking at the role of agriculture, suburban, riparian, wetlands, rivers, and estuaries (Vallino per comm 2000).

   In the Ipswich Watershed, a model is being developed to show the conversion of forest to agricultural and urban areas. The estimate of deforestation will be integrated with a map of nutrient flows by looking at land use in the watershed (Pontious per comm 2000).

   Also in the Ipswich Watershed, the effect of land use and climate change on basin scale hydrology is being modeled. As part of this study, water diversions, historic water budgets, and nutrient sampling stations will be used to help model nutrient dynamics. The model will construct a relationship of nitrogen and land use to examine the processing and recycling of nutrients (Claessens per comm 2000).

   In the future, the LTER project will develop a model for Plum Island Sound that integrates much of the ongoing research by linking the benthic areas, water column, and marsh. This model will examine flooding of the marsh (bathymetry and marsh topography data will be developed to include as part of this model), phytoplankton dynamics, biochemistry patterns, benthic ecology, and nutrient transport as a way to synthesize ongoing research (Vallino per comm 2000).

Long-term experiments (10-15 years) are also being planned as part of the LTER project to continue assessing basic marsh functions and to understand impacts of human alterations on the watersheds. Proposed long-term experiments include creek fertilization by adding nitrogen and

phosphorus to tidal portions of creeks, detritus removal by studying active haying sites, marsh fertilization by sprinkling nutrients on the marsh surface, and carbon dioxide measurements across the air/water interface through research at the Woods Hole Oceanographic Institute. These future experiments in addition to ongoing research will continue to increase our knowledge and research base for the watersheds and estuaries of the Parker River/Essex Bay ACEC. *To see results and ongoing LTER project updates, visit the website at http://www.mbl.edu/PIE/.*

SUMMARY

The Parker River/Essex Bay ACEC is recognized as a unique complex of ecosystems with environmental, economic, and recreational significance. Although this region with natural and human resource values remains relatively pristine, ever-increasing development pressures threaten many of the fragile resources. Long term protection of these estuarine, riverine, salt marsh, and barrier beach ecosystems requires continued research to document change through time. Future research that builds on our existing knowledge should be used to modify management and planning strategies, bolster education efforts, and design technical assistance programs. Fortunately, an extensive network of agencies, conservation groups, and local communities are working hard to address natural resource issues in the ACEC (Appendix C). Collaboration among these groups will continue to strengthen the monitoring, restoration, protection, and outreach efforts currently underway.